A transition approach from a local second gradient model to a cohesive zone model

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Among the various regularization methods that enable to deal with the problem of strain localization in the framework of continuum mechanics, the class of generalized continua introduces an internal length by taking into account additional kinematics terms into the virtual power principles. As a particular case of this type of continua, the local second gradient model developed by Chambon and coworkers [1] has been successfully used for soils where the main problem is shear banding. More recently, it has been also used in the context of damage mechanics for concrete structural elements [2] where strains mainly localize under the first mode of crack propagation.

We show that this type of strain localization can become problematic for the second gradient model. Indeed, the forces transmitted through the crack do not necessarily vanish for high values of damage. This is due to the the additional stresses, the so-called double stresses, of the second gradient model. Another problem, common among regularization techniques, is the continuous spreading of the localization band again for similarly high damage values (fully formed cracks).

Following the work by Comi et al [3] and Cuvilliez et al [4] for different regularization methods, we propose to deal with theses issues applying a transition to a cohesive zone model. In this way, the various phases of strain localization and fracture can be correctly modeled : from diffuse damage to localization till finally to a fully formed crack. The theoretical formulation and finite element implementation are discussed with special care to the additional boundary conditions which naturally appear in a second gradient continuum. Application to a 3 point bending test on a notched beam illustrates the limitations and the advantages of the approach. The results show that the new model is more adequate to represent the full experimental force displacement curve.

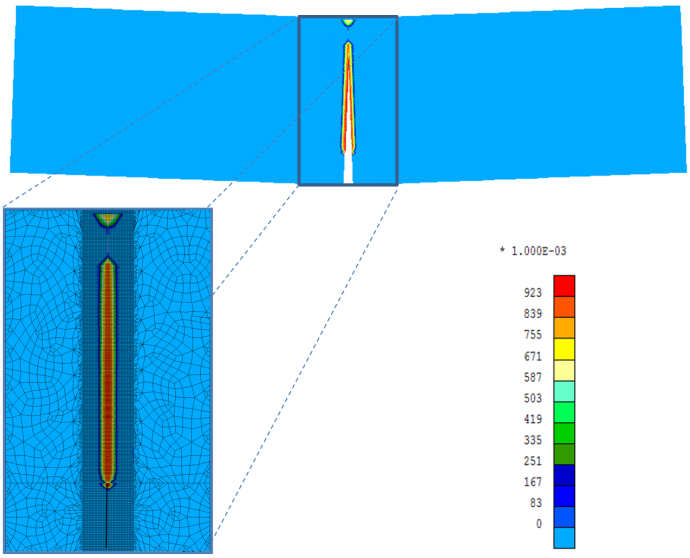

FIGURE 1 – 3 point bending test : Damage distribution at the notch tip with open cohesive zones

Références

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